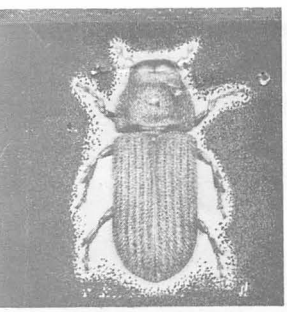

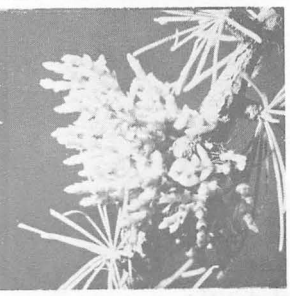

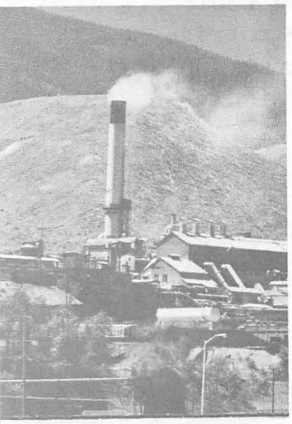

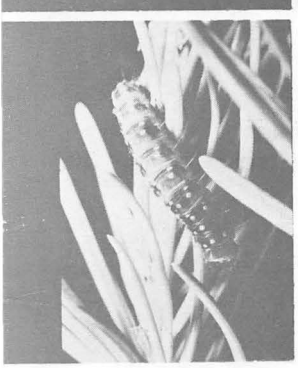

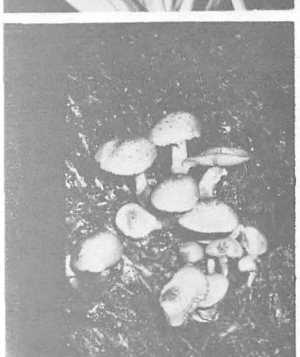

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WESTERN SPRUCE BUDWORM IMPACT EVALUATION, YOOSA CREEK, CLEARWATER NATIONAL FOREST, IDAHO--1974

by

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INTRODUCTION

Western spruce budworm *Choristoneura occidentalis*, Freeman, has been at epidemic levels on portions of the Clearwater National Forest since 1966. Intensity has fluctuated annually, and by 1970 some stands were beginning to show evidence of permanent injury. In 1971, impact evaluations were initiated and an infested stand in Yoosa Creek was selected as a sample site. Two other areas have since been added to the sample base (Franc et al., 1973).

METHODS

After stand boundaries were delineated on aerial photographs, survey strips 10 chains apart in cardinal direction were established. Twenty BAF plots were established along the survey lines at 5-chain intervals. All plot trees were marked for remeasurement purposes. (Franc, et al., 1972).

At the 1974 remeasurement period all trees were examined and measured for volume. In addition each tree was classified as to the following code.

1/ Entomologist, Forest Environmental Protection, Missoula, Montana.

2/ Forestry Technician, Clearwater National Forest.

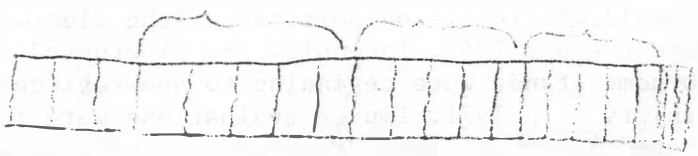
3/ Biological Technician, Forest Environmental Protection, Missoula, Montana.

Damage Intensity

0 - Not defoliated
1 - Light defoliation (0 to 25 percent)
2 - Moderate defoliation (25 to 50 percent)
3 - Heavy defoliation (50 to 75 percent)
4 - Extreme defoliation (75 to 100 percent)
5 - Top kill by budworm
6 - Killed by budworm

Growth impact information was obtained by collecting one increment core from each of the two trees nearest plot center regardless of species at each variable plot. Cores were placed in straws and identified so that species and size could be determined later. Increment cores were refrigerated until examined under a binocular scope and the last 15 years' growth measured to the nearest one-hundredth of an inch in 5-year increments (Figure 2).

Figure 2. Radial increment core showing growth period measurements for impact analysis.



Tree size and growth data from 160 cores were obtained and entered into a computer program (PREDIC) which calculates actual and predicted volumes. This technique involves estimation of tree diameter and height 5 years ago based on the actual growth during that period. Predicted size can now be calculated using radial and height growth predictions based on the previous 10-year growth period.

The following methods and formulae are used in the computer program: Diameter 5 years ago is established by subtracting radial growth from present diameter.

D-5 = D-(0-5 yr. x 2).

Where: D-5 = Diameter 5 years ago
D = Present diameter
0-5 yr. = 5-year radial growth

Formulae for predicting height growth based on radial growth are available from the Timber Management Group and are used in the Stage II computer program.

Formula for predicting height 1 year from now is as follows:

$$H+1 = H+\frac{ASP}{10} + 0.2464 \times \frac{H}{D} \quad \frac{(2D - di) \times (di)}{10\ (D+D1)}$$

Where H + 1 = Height 1 year from now
H = Present height
ASP = Constant for each tree species
di = Diameter growth for 10-year period (2 x radial growth)
D = Present diameter
D1 = Diameter 1 year from now[4/]

To determine periodic height growth for the last 5 years based on actual diameter growth, the formula is rearranged and appears as:

$$H-1 = (H-A/10) \div 1 + \left(.2464 \div D \times \frac{(2\ D1 - di_2) \times (di_2)}{10\ (D-1 + D)}\right)$$

Where H-1 = Tree height 1 year ago
H = Present height
D = Present diameter
D-1 = Diameter 1 year ago = $D - (2 * \frac{0\text{-}5 \text{ years}}{5})$
Di_2 = 4* (0-5 year radial growth)
Other terms as previously described.

Periodic height growth can now be computed based on past 5-year radial growth measurements and the size of the tree 5 years ago is determined. Predicted diameters and heights are now computed using the same formula but substituting predicted diameter growth measurements based on growth rates prior to budworm defoliation. Volumes are computed for both actual and predicted and a "t" test determines significant differences.

RESULTS AND DISCUSSIONS

Remeasurement of the Yoosa Creek block has shown that grand fir and subalpine fir is more severely defoliated than other host trees. Eighty-nine percent of the grand fir volume occurs in defoliation Class 3 (heavy) or greater, and 100 percent of the volume of subalpine fir is in Class 4 (extreme) or greater (Table 1). Similar results occur in trees per acre with 90.3 percent of the grand fir in defoliation Class 3 or greater and 100 percent of the subalpine fir in Class 4 or greater. Only 11.5 percent of the Douglas-fir trees were in Class 3 or greater and 23.6 percent of the spruce trees in Class 3 or greater. Some mortality was observed in subalpine fir, grand fir, and Douglas-fir (Table 2).

4/ $D1 = \sqrt{D^2 + \frac{(2D - di) \times (di)}{10}}$

Table 1.--Volume per acre (bd. ft.) by species and spruce budworm damage class, Yoosa Creek, Clearwater National Forest, Idaho, 1975.

Species	Total volume	Damage classes													
		(0) Not infested		(1) Light		(2) Moderate		(3) Heavy		(4) Extreme		(5) Top kill		(6) Mortality	
		Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%	Vol.	%
Grand fir	9,300	201	2.2	136	1.5	686	7.4	2,782	29.9	4,581	49.3	869	9.3	45	.5
Engelmann spruce	2,447	0	0	1,480	60.5	548	22.4	358	14.6	61	2.5	0	0	0	0
Douglas-fir	1,286	315	24.5	801	62.3	53	4.1	1	.08	0	0	99	7.7	17	1.3
Subalpine fir	808	0	0	0	0	0	0	0	0	664	82.2	135	16.7	9	1.1
Mountain hemlock	154	0	0	38	24.7	54	35.1	0	0	0	0	62	40.3	0	0
Western white pine	209	209	100	0	0	0	0	0	0	0	0	0	0	0	0
Cedar	490	490	100	0	0	0	0	0	0	0	0	0	0	0	0
Larch	135	135	100	0	0	0	0	0	0	0	0	0	0	0	0

Table 2.--Trees per acre by species and spruce budworm damage class, Yoosa Creek, Clearwater National Forest, Idaho, 1974

Species	Total	Damage class													
		(0) Not infested		(1) Light		(2) Moderate		(3) Heavy		(4) Extreme		(5) Top kill		(6) Mortality	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Grand fir	60.8	0.7	1.2	0.6	1.0	4.6	7.6	20.0	32.9	25.6	42.1	8.9	14.6	0.4	0.7
Engelmann spruce	17.8			9.3	52.2	4.3	24.2	2.9	16.3	1.3	7.3				
Douglas-fir	11.3	3.2	28.3	5.8	51.3	1.0	8.9	.7	6.2			.4	3.5	.2	1.8
Subalpine fir	5.6									3.9	69.6	.7	12.5	1.0	17.9
Mountain hemlock	.5			.1	20.0	.2	40.0					.2	40.0		
Western white pine	1.2			1.2	100.0										
Cedar	1.7			1.7	100.0										
Larch	.2			.2	100.0										

The analysis of increment cores also shows similar results with subalpine fir displaying the greatest impact followed by grand fir. Analysis showed that significant growth loss occurred only on subalpine fir and grand fir. Spruce was least affected by western spruce budworm feeding. There were insufficient cores to analyze growth impact on nonhost trees. This should be corrected in the future to purposely include more nonhost species to make meaningful comparisons. However, when a "t" test was used to test volume differences between actual and predicted, significant differences were detected in subalpine fir and grand fir (Table 3).

Annual growth loss on Yoosa Creek was estimated to be 30.89 board feet per acre. This was derived by using the growth impact ratio for each species and applying it to the total volume (Table 4). This growth loss was almost identical to the value of 29 board feet per acre reported in 1973 (Franc, et al., 1973). However, growth data in 1973 was from four areas on the Clearwater National Forest of which one was Yoosa Creek. Evidently the Stage II computer program provides similar volume results when entries are modified as was done in 1973. Total growth loss in Yoosa Creek for the 5-year period is 77,225 board feet. Mortality attributable to budworm equalled 26,642 board feet. Regression analysis was used on grand fir growth data to determine the relationship between defoliation index and cubic feet growth loss. Results show that tree growth decreases with an increase in defoliation index; that is, trees most severely defoliated showed the greatest growth loss. The regression equation is as follows:

$$Y = 1.807 - .6950 * X \quad F = 3.588+$$

Where: Y = difference in growth
X = tree rating

\+ significant at the 5% level

The computer program (PREDIC) identifies species contributing to impact and the statistical significance of the data can be determined. Continued testing is planned and modifications will be made as needed.

Table 3.--Spruce budworm growth impact by species (cubic feet) Yoosa Creek, Clearwater National Forest, Idaho, 1974[1/]

Species	Item	Total volume	Mean volume per tree	Degrees of freedom	"Students" t-ratio
Grand fir	Actual volume	11,322.20	124.22	90	-2.560*
	Predicted volume	1,139.70	125.22		
	Mean difference	-.8069 ± .3151[2/]			
Spruce	Actual volume	2,329.91	83.21	27	-0.124 NS
	Predicted volume	2,330.64	83.23		
	Mean difference	.0259 ± .2089			
Douglas-fir	Actual volume	1,641.40	78.16	20	-1.479 NS
	Predicted volume	1,654.86	78.80		
	Mean difference	-.640 ± .433			
Alpine fir	Actual volume	562.80	46.90	11	-3.011*
	Predicted volume	571.50	47.62		
	Mean difference	-.7246 ± .2406			

1/ Volume obtained from increment core sample trees.
2/ One standard error of the difference.
* Significant at the .05 level.

Table 4.--Board feet volume per acre in Yoosa Creek, Clearwater National Forest, Idaho, 1974.

	Actual volume 1/	Predicted volume 2/	Difference
Grand fir	9,122	9,181.11	
Engelmann spruce	2,443	2,443.75	
Douglas-fir	1,272	1,282.43	
Larch	153	153.00	
Western white pine	209	209.00	
Cedar	490	490.00	
Mountain hemlock	154	154.00	
Subalpine fir	799	883.20	
	14,642	14,796.49	154.49

$\frac{154.49}{5}$ 3/ = 30.89 board feet per acre/year

1/ Volumes obtained from the sale cruise printout.
2/ Predicted volumes from growth impact analysis.
3/ Volume differences divided by number of years of spruce budworm defoliation.

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